Agroecology in higher education: a multidimensional vision as a resilience strategy to climate change

M.C. Dussi[1], L.B. Flores[1], M.E. Barrionuevo[2] and S.E. Dussi[1]

[1]Department of Agricultural Sciences, Comahue National University, Cinco Saltos, Argentina; [2]Instituto Nacional de Tecnología Agropecuaria, Plottier, Argentina.

Abstract

The current agro-industrial model faces several problems today, both globally and regionally. To ensure a sufficient supply of healthy and nutritious food for the growing world population, agriculture will need to use the soil properly, use less oil, less water and less nitrogen. To understand the need to move toward a new paradigm, new approaches, criteria and ways of understanding reality from a multidimensional and ethical perspective are required. The present work aims to consolidate innovative learning processes with the purpose of strengthening capacities in university students that allow them to debate, establish agreement and propose solutions to agricultural production systems. At Comahue National University, a study was conducted with a population of students studying agroecology in 2014-2016. The students were divided into groups of four. Each group was assigned a regional productive unit (PU) to carry out field work using the sustainability indicators technique. From the results obtained, each group proposed suitable management alternatives to increase sustainability in the PU's. At the end of the project work, students were able to define the problems in each PU, propose and discuss diverse hypotheses, and propose different management alternatives, taking into account the critical points detected in the agroecosystems analyzed. Students showed high levels of motivation, interaction with stakeholders and solved specific agronomic problems, based on agroecology as an alternative response to industrial agriculture.

Keywords: participatory methodology, sustainability indicators, multidimensional thinking

INTRODUCTION

Agroecology is a new field of knowledge: a scientific discipline that brings together, synthesizes and applies knowledge of agronomy, ecology, sociology, ethnobotany and other related sciences, with a holistic, systemic approach and a strong ethical component. It generates knowledge, validates and applies appropriate strategies to design, manage and evaluate sustainable agroecosystems (Dussi et al., 2014, 2015, Dussi and Flores, 2018; Flores et al., 2010, 2011).

The agro-industrial model faces several problems today, both globally and regionally. Hence there is an urgent need to promote a new agricultural paradigm that will facilitate the production of a sufficient quantity of healthy and nutritious food for a growing population, in a context of socio-economic vulnerability and climate change. It is not a viable option to continue with the current system that is very resource demanding, non-sustainable and which fails to reflect environmental externalities (Altieri, 2009).

To understand the need to move to a new paradigm, it is essential to provide comprehensive training to professionals in the agricultural and related sciences, in new alternative approaches, criteria and ways of understanding reality from an ethical and multidimensional perspective. Agriculture must prioritize medium and long-term strategies in relation to ecological, social, political and cultural aspects that promote sustainable agriculture (Zon et al., 2011; Dussi et al., 2014, 2015; Dussi and Flores, 2018). Through the study of real life cases, using a participatory methodology and systemic analysis, university students can generate new questions and new solutions (Dussi et al., 2011).

The present work aims to consolidate innovative learning processes with the purpose

Acta Hortic. 1258. ISHS 2019. DOI 10.17660/ActaHortic.2019.1258.11
XXX IHC – Proc. XIX Symp. on Hortic. Econ. and Mgmt., VII Symp. on Supply Chains,
II Symp. on Econ., Mktg. and Consumer Research and VIII Symp. on Educ. and Consultancy
Ed.: P.J. Batt

of strengthening capacities in university students that allow them to debate, establish agreement and propose solutions to agricultural production problems.

MATERIALS AND METHODS

Through the Department of Agricultural Sciences at Comahue National University, Patagonia, Argentina, the population of agroecology students in the years 2014-2016 were placed into groups of four students. The teaching team then assigned these groups to a regional productive unit (PU) placed in different localities along a 100 km transect of Alto Valle region of Northern Patagonia (Figure 1).

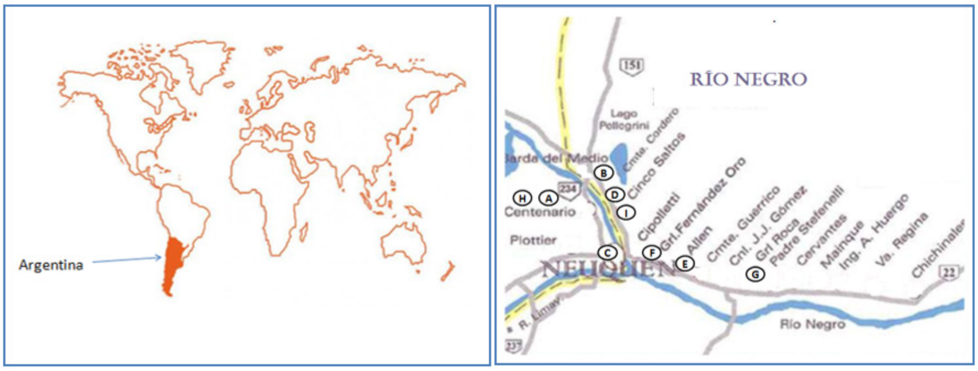

Figure 1. Geographic location (39° LS) of the productive units assigned to the students, to carry out the fieldwork of the subject Agroecology, Department of Agricultural Sciences, Comahue National University, Patagonia, Argentina, during the years 2014, 2015 and 2016. A. Conventional vegetable production (Centenario); B. Conventional vegetable production (Contralmirante Cordero); C. Community Urban agriculture (Neuquén); D. forage production (Cinco Saltos); E. conventional fruit production (Allen); F. hop production (General Fernández Oro); G. organic fruit production (General Roca); H. conventional fruit production (Centenario); I. organic fruit production (Cinco Saltos).

Each group prepared a number of reports. Fieldwork No. 1 conceptualized the agroecosystem, identifying and relating the components and interactions in the assigned PU. Likewise, they elaborated the energy flux and nutrient cycle of each agroecosystem analyzed.

In Fieldwork No. 2, the group constructed the sustainability indicators with the producers, workers and technicians, considering the ecological, social and economic dimensions (Dussi and Flores, 2018).

The approach consisted of two theoretical and practical workshops that were inputs for further work in the field. For the theoretical component, each group read and analyzed bibliographic material. Then, in the practical component, the students participated in group discussions, presentations in plenary sessions and debates based on individual experiences. Later, in a collaborative way, they made questionnaires which were used in the field.

After the workshops, the students visited the PUs and interviewed different stakeholders of the assigned farms (producers, agronomists, workers). Among the activities carried out, the students recorded their observations in field notebooks; soil, water and leaf analysis; Shannon diversity index; soil compaction; living and education standards of the workers and producers; access to training courses; job satisfaction and farm profitability.

They elaborated a scale of measurement for the identified indicators and made an evaluation of the sustainability of the agroecosystem analyzed, proposing at the end, management alternatives to increase sustainability.

Each group presented a written report that was corrected and analyzed by the teaching team. They also had to make a 20 min. oral presentation where all the students, faculty members, guest lecturers, producers, workers and technicians of each PU were present.

To gain a concrete perspective of what was developed during the course and the impact of the didactic innovation, the students were asked to answer a questionnaire:

1. Were the objectives stated fulfilled?
2. Was the methodology used during the practical work interesting?
3. Did it generate questions?
4. Did the practical work provide you with tools to understand the concepts of the subject?
5. Did the knowledge acquired in agroecology allow you to visualize the solution of problems in the productive system?
6. Was the workshop methodology used useful to meet the objectives of the practical work?

The responses to each question were: Yes, Partially, or No.

RESULTS AND DISCUSSION

In the oral presentations, the students presented well-founded conclusions, answering questions and discussions that were generated in the classroom. Lecturers, guest lecturers, producers, workers and technicians from each PU participated in the oral presentations, generating a space for discussion, reflection and exchange.

The activities undertaken contributed 50% of the final grade, with two written examinations comprising the balance. Points evaluated for the written report were: quality of written reports; depth of the analysis performed; quality and relevance of the bibliography used, and for the oral presentations, quality and clarity of the presentation, support material used; time management; individual participation and team performance.

The 14 groups of students managed to build 58 sustainability indicators in the ecological dimensions, 55 in the social dimension and 39 in the economic dimension. In addition, students identified the critical points within each PU (Table 1) and based on those, presented different management proposals for the agroecosystems analyzed.

From the final individual and written survey completed by all the students at the end of the course during the three years of study (2014, 2015 and 2016), it was observed that 93% of the students surveyed thought that the objectives stated in the practical work were met and 89% considered the methodology used to be interesting. Some 88% considered that this participatory methodology had generated new questions and 96% believed that the practical work provided them with tools to understand the concepts of the subject. Of the students surveyed, 91% believed that agroecology, as a discipline, allowed them to visualize the solution of problems in agricultural production systems from a multidimensional and holistic perspective. Finally, 86% of the students thought that the workshop methodology used was useful in meeting the objectives of the practical work.

CONCLUSIONS

Students were able to define the problems of each productive unit, propose and discuss different hypotheses and propose different management alternatives to improve sustainability in agroecosystems, based on the critical points detected by the indicators used.

A high degree of student motivation was observed when performing the assigned tasks since, from the didactic resources used, they managed to interact with the different stakeholders of the productive system and to solve specific agronomic problems from a multidimensional and holistic systems-based perspective. They acquired tools to deepen the dialog of knowledge and horizontal exchange of experiences. The workshops encouraged the exchange of knowledge of the students among themselves, with producers and the team of professors.

These agroecological training processes should enable future professionals in the agricultural sciences to integrate the different dimensions of sustainability and to apply new solutions to address the climatic, economic and environmental conflicts that are present in current agro-industrial farming practices.

Finally, the work proposed by the Chair of Agroecology strengthened the links between the university and external and internal stakeholders.

Table 1. Indicators of sustainability and critical points (in italics and underlining) of different PUs, made by each group of Agroecology students.

Year	Productive units (PU)	Ecological indicators	Social indicators	Economic indicators
2014	Conventional vegetable production (Contralmirante Cordero) Student group 1	- Soil pH - Soil organic matter - Soil electrical conductivity - Exchangable Sodium percentage (ESP) - Pest and disease management - Management of arvense flora	- Housing availability - Drinking water - Family labor - Access to drinking water - Producers training - PU infrastructure - Degree of technology used - Workers training	- Degree of associativism *- Land tenure* *- Machinery availability* - Destination of the products
	Community urban agriculture (Neuquén) Student group 2	- Irrigation water availability *- Irrigation water source* - Irrigation water quality - Plant community equitability - Container vegetable depth - Land use efficiency - Organic waste recycling - Pests control - Fertilization management - Crops damage observation - Pests and predators monitoring	- Age of urban farmers - Urban farmers education level - Permanence of the families in the community garden - Weekly dedication to the garden - Need of extra vegetable garden purchase - Family members participation level - Workshops attendance - Labour satisfaction level - Relation among coworkers	- Government supports - Support of other entities - Percentage of urban families that sell horticultural products - Percentage of urban families that exchange horticultural products - Yield per crop
	Forage production (Cinco Saltos) Student group 3	- Percentage of canopy cover in the alleyway[a] *- Plant diversity* *- Soil organic matter* - Soil electrical conductivity - Soil pH	*- Technical assistance* *- Producer training* - Women work	*- Income* *- Diversification of product for sale* *- Marketing Pathways*
	Conventional fruit production (Allen) Student group 4	*- Plant diversity* - Variety number - Codling moth damage - Fruit sunburn damage - Oriental fruit moth damage - Mechanically damaged fruit - Weather report reading	- Technical assistance - *Workers training* - Training on new technologies - Toilets availability - Housing availability - Maintenance of the installations - Social security and insurance	- Degree of mechanization - Use of machinery - Rentability

[a]Space between two tree fruit rows.

Table 1. Continued.

Year	Productive units (PU)	Ecological indicators	Social indicators	Economic indicators
	Conventional fruit production (Allen) Student group 4	- *Pests, diseases and weeds control* - *Contamination*[a] - Soil salinity - Exchangable Sodium percentage (ESP) - Soil drainage - Soil pedregosity - Soil organic matter		
	Hop production (General Fernández Oro) Student group 5	- Shannon index - *Soil organic matter* - Soil salinity - Exchangable sodium percentage (ESP) - *Salinituy of irrigation water*	- Relationship with research institutions - Workers training - Legality of the work contracts - Work risk insurance. - *Toilets availability*	- Marketing Pathways - Diversification of product for sale - Average yield - *Dependence of external inputs*
2015	Community Urban agriculture (Neuquén) Student group 1	- Management techniques - *Certifications* - Soil Structure - *Container vegetable depth*. - Land use efficiency	- Drinking water - Toilets availability - Urban gardeners training - Type of assistance received	- Marketing route - Number of productive activities - *Irrigation efficiency* - *Efficiency of low tunnels and greenhouses* - Crop rotation
	Forage production (Cinco Saltos) Student group 2	- Shannon index - Soil electrical conductivity - Soil compaction - Soil pH	- *Producers Health* - *Technical assistance* - *Degree of satisfaction of producer needs*	- Crop yield - Production quality - Marketing pathway - *Hectares with forage production / economic production unit*
	Hop production (General Fernández Oro) Student group 3	- Irrigation system - Irrigation water conductivity - Sodium in the Irrigation water - *Soil pH* - Water irrigation alkalinity - *Soil organic matter* - Soil electrical conductivity - Exchangable sodium percentage (ESP) - Waste recicling - *Pest monitoring* - Shannon index - Poplars as wind brake	- Distance to urban areas - Availability of services - Workers training - Security at work - *Presence of Echerichia coli in drinking water* - Presence of *Pseudomonas* in drinking water - Presence of nitrates in drinking water - Arsenic in drinking water - Dissolved solids in drinking water - Salinity in drinking water	- Crop yield - Tractors yearly use

[a]Pollution due to the presence of hydrocarbons because this PU has an oil extraction platform between the fruit plantation.

Table 1. Continued.

Year	Productive units (PU)	Ecological indicators	Social indicators	Economic indicators
	Organic fruit production (Cinco Saltos) Student group 4	- Percentage of canopy cover in the alleyway - Diversity - Soil organic matter - Water availability - Irrigation water quality	- Salary of employees/basic food basket - Average salary of PU employees / average salary of other jobs *- Employees education level* - Access of employees to a training on new technologies	*- Number of tractors per hectares* - Crop yield
2016	Hop production (General Fernández Oro) Student group 1	- Soil organic matter - Soil total N - Soil pH - Good agricultural practices application - Plant community equitativity	- Frequency of training programs - Staff response to satisfaction surveys - Quality of transport service - Quality of cleaning service	- Rentability of bitter hops varieties *- Rentability of aromatic hops varieties* *- Hops suppliers payments* *- Suppliers input payments* - Diversification of products for sale
	Conventional fruit production (Centenario) Student group 2	*- Shannon index* - Crop diversity - Fruit damaged by tomato moth - Codling moth damage - Presence of beneficial organisms *- Form of tillage*	- Participation in cooperatives - Technical assistance - Producer training - Workers training	*- Apple yields* *- Pear yields* *- Stone fruits yields* *- Crop quality* - Marketing routes - Transport cost
	Organic fruit production (Cinco Saltos) Student group 3	- Resources inputs ratio - Soil organic matter - Shannon Index	- Drinking water - Workers insurance - *Workers training* - Housing availability	- Crop yield - Access to credits - *Diversification* of products for sale - Marketing routes
	Organic fruit production (General Roca) Student group 4	- Energy efficiency - Soil organic matter - Percentage of canopy cover in the alleyway - Soil salinity	- Basic needs - Grower scholarity - Technical assistance - Workers training	*- Marketing routes* - Apple yields - Pear yields - Stone fruits yields - Diversification of products for sale
	Conventional horticultural production (Centenario) Student group 5	*- Management of pesticide resistance* *- Integrated pest management* - Irrigation water availability - Soil pedregosity	- Technical assistance - Toilets availability - Elements of personal protection - Deposit of agrochemicals - Participation of women in business management - Knowledge exchange with other producers	- Diversification of products for sale - Power of negotiation - Cost benefit ratio

Literature cited

Altieri, M.A. (2009). Agroecology, small farms and food sovereignty. Mon. Rev. *61* (*3*), 102–111 https://doi.org/10.14452/MR-061-03-2009-07_8.

Dussi, M.C., and Flores, L.B. (2018). Visión multidimensional de la agroecología como estrategia ante el cambio climático. Interdisciplina, *6* (*14*). http://www.revistas.unam.mx/index.php/inter/issue/view/4844/ showToc

Dussi, M.C., Candan, F., and Gastiazoro, J. (2006). Técnicas de aprendizaje para abordar problemas agronómicos desde la Ecología. Paper presented at: XXII Reunión de Ecología ((Córdoba, Argentina).

Dussi, M.C., Flores, F., Gastiazoro, J., and Zon, K. (2011). Utilización de indicadores para evaluar sustentabilidad en Agroecosistemas. Experiencia en Educación superior. Paper presented at: VIII Convención Internacional sobre Medio Ambiente y Desarrollo. La Habana. Cuba.

Dussi, M.C., Flores, L.B., and Barrionuevo, M.E. (2014). Agroecología y educación: multidimensión en la comprensión de sistemas complejos en Patagonia. Paper presented at: XVII Jornadas Nacionales de Extensión Rural y IX del Mercosur: El encuentro en la diversidad (Santa Fe, Argentina: Zavalla).

Dussi, M.C., Flores, L.B., and Barrionuevo, M.E. (2015). Sustentabilidad en agroecosistemas frutícolas. VII Jornadas de la Asociación Argentino-Uruguaya de Economía Ecológica. ASAUEE. 9 al 12/11 (Neuquén).

Flores, L., Dussi, M.C., and Gastiazoro, J. (2010). Estado de la Agroecología en la Universidad Nacional del Comahue. Seminario Taller en Agroecología: Desafíos y posibilidades de la incorporación del enfoque de la Agroecología en las Instituciones de Educación Agropecuaria (Universidad Nacional de La Plata).

Flores, L., Dussi, M.C., Gastiazoro, J., and Zon, K. (2011). Evaluación de sustentabilidad en agroecosistemas mediante el uso de indicadores como propuesta educativa universitaria. Paper presented at: XXXIV Congreso Argentino de Horticultura (Buenos Aires, Argentina).

Zon, K., Dussi, M.C., Flores, L., and López, A. (2011). “Comercio justo”: una alternativa diferente para la comercialización de peras? Paper presented at: VIII Convención Internacional sobre Medio Ambiente y Desarrollo (La Habana, Cuba).